Mott transition observed by micro-Raman scattering in VO_2*

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Abstract

A strongly correlated Mott first-order metal-insulator transition (MIT) (or Jump) not accompanied by the structural phase transition (SPT) was clearly revealed in VO_2, (New J. Phys. 6 (1004) 52, Appl. Phys. Lett. 86 (2005) 242101, Physica B 369 (2005) 76). In order to re-confirm the MIT for a VO_2-based device with a narrow width of 3 μm and a length of 20 μm such as a rod (Fig. A), both phonon peaks (Fig. B) by a micro-Raman scattering with a laser beam of about 5 μm and the MIT with jump in I-V curve (Fig. C) were simultaneously measured. A device like a rod has less inhomogeneity. The current was restricted for measurements. The phonon peaks of monoclinic exist even after the abrupt jump, and disappear in over 10 mA. The jump was changed to negative differential resistance type during Raman measurement after the jump. The high current causes a Joule heat which arises from the SPT near 68°C from monoclinic to tetragonal. The clean film surface without a breakdown damage after several measurements was taken by a micro-photograph camera (Fig. A). The MIT (jump) occurs prior to the SPT and not affected by the SPT as evidence of electron-phonon interaction. Thus VO_2 is a Mott insulator not Peierls insulator.

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FIGURES

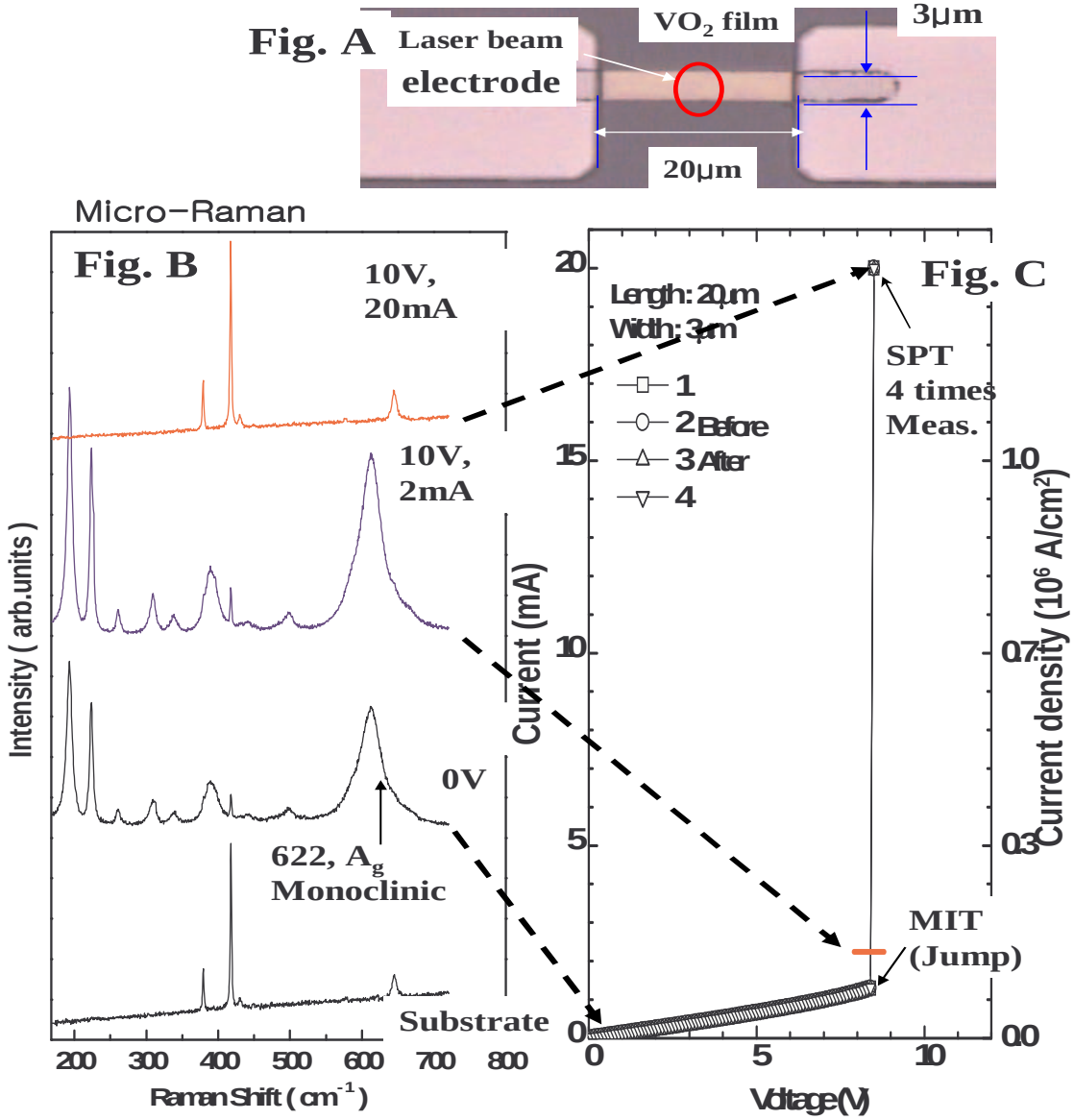

FIG. 1. Fig. A.: Device photograph taken after measurements. Fig B: Micro Raman spectra. Fig. C: Jumps of two times before and after Raman measurement were measured.